Part 0

Preliminaries

What is a Computer?
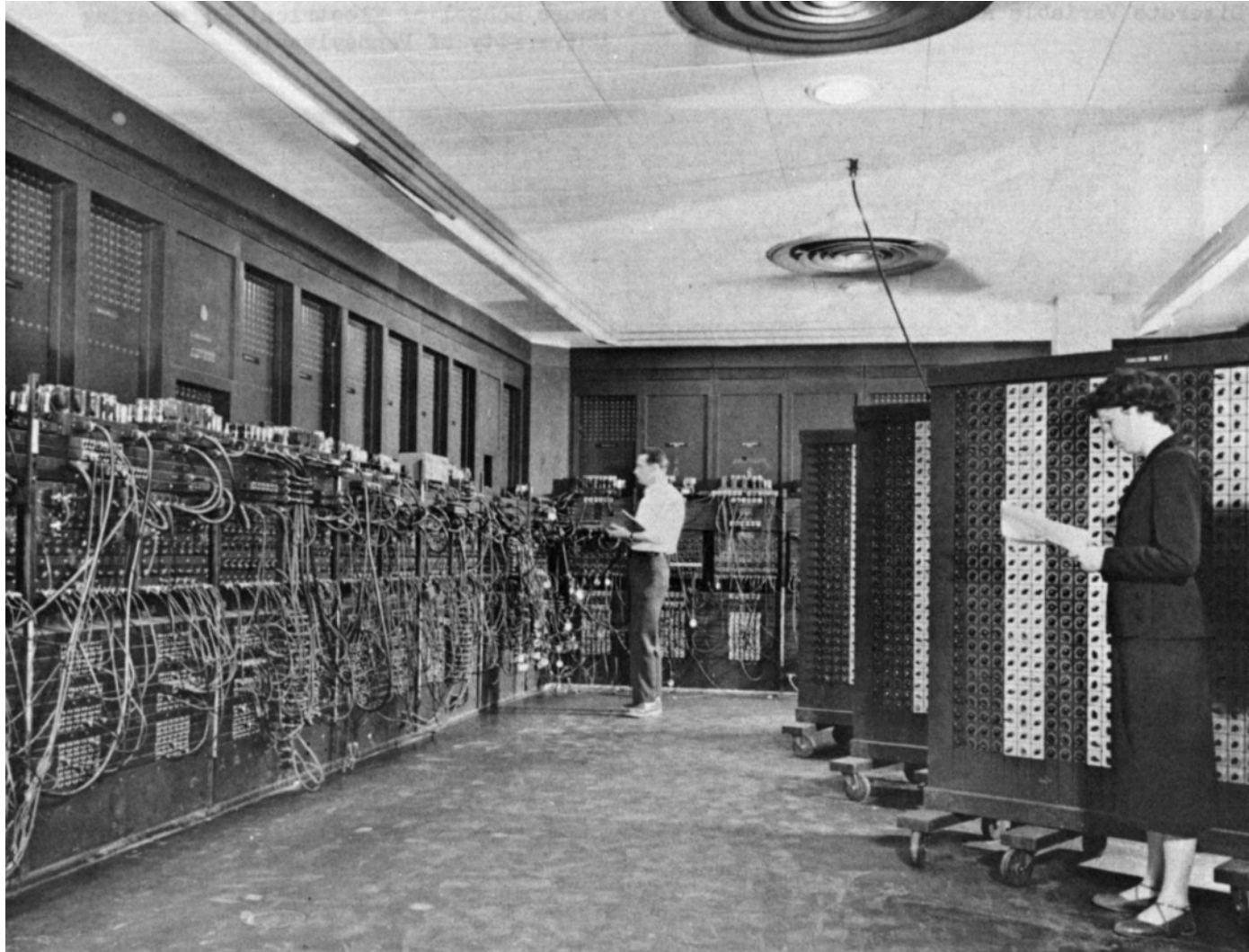
What is a Computer?

CPU (Central Processing Unit)

registers

R0	
R1	
R2	math
R3	
R4	
R5	
R6	
R7	

ALU

control unit

PC
SP

load
store

memory

data
```
5548 89e5 897d
fc00 0f8e 1800
45f8 8b45 fc83
8b45 f85d c300
```

program
```
ADD R1, R2, R3
SUB R3, R4, R5
...
STO R5, (R6)
```
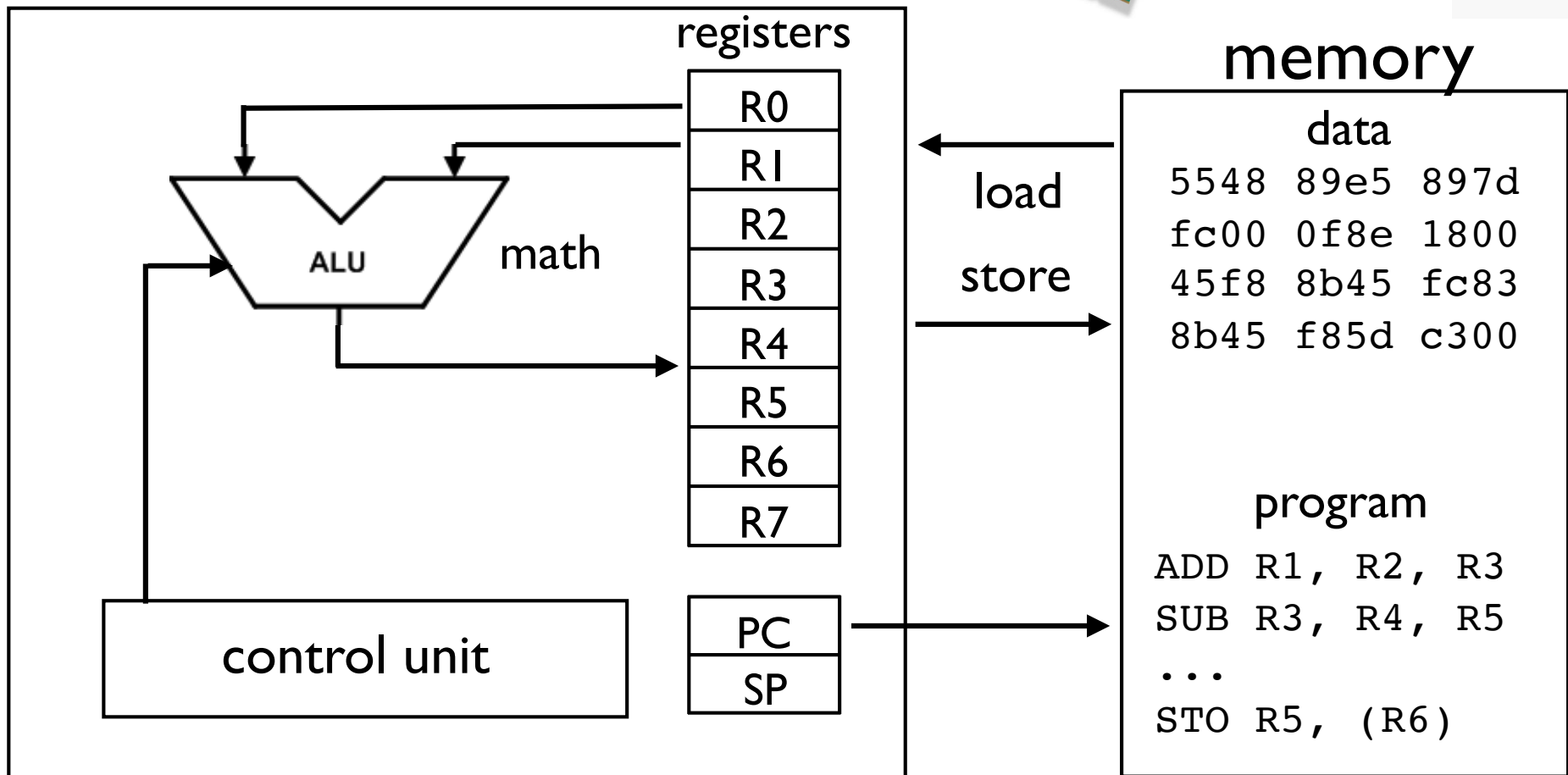
What is a Computer?

- Computers are not especially "smart"

- Glorified calculator (with program memory)

- Example:

```
2 + 3 * 4 - 5

MOV 2, R1              ; R1 = 2
MOV 3, R2              ; R2 = 3
MOV 4, R3              ; R3 = 4
MUL R2, R3, R4         ; R4 = R2 * R3 = 3 * 4 = 12
ADD R1, R4, R5         ; R5 = R1 + R4 = 2 + 12 = 14
MOV 5, R6              ; R6 = 5
SUB R5, R6, R7         ; R7 = R5 - R6 = 14 - 5 = 9
```

What is Computation?

"Computer Science is no more about computers than astronomy is about telescopes."

What does it actually mean to "compute" something?

What can be computed?

What is Computation?

- It's a process or procedure

```
Compute: 5!      -> 5 * 4 * 3 * 2 * 1

result = 1
n = 5
while n > 0:
    result = result * n
    n = n - 1
```

- Step-by-step sequence of operations

- Pressing buttons on the calculator

What is Computation?

- But, what is the actual essence of "computation?"

- Give me a minimal definition of it...

Deep Idea

- Computation is repeated substitution

$$2 + \mathbf{3} * \mathbf{4} - 5$$

↓ substitute (eval 3 * 4)

$$\mathbf{2 + 12} - 5$$

↓ substitute (eval 2 + 12)

$$\mathbf{14 - 5}$$

↓ substitute (eval 14 - 5)

$$\mathbf{9}$$

- Maybe overly simplified, but computation is a process of substituting one thing for another

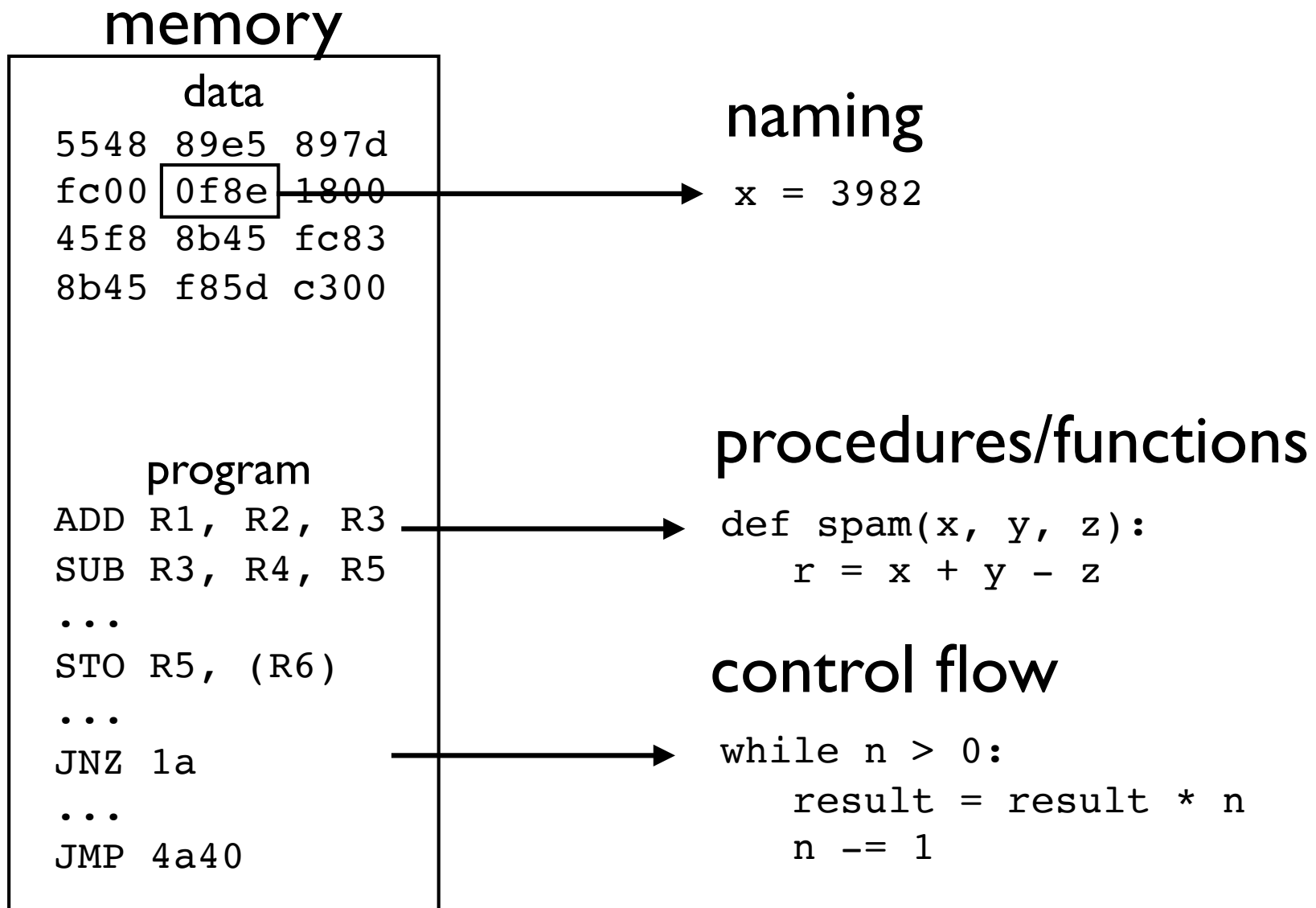- Stops when no more steps are possible

Substitution

- Substitution is a major facet of compiler writing

- "High level" things are replaced by "lower level" things (repeat until you can't go any further)

- Part of moving from an abstract programming language down to the actual hardware

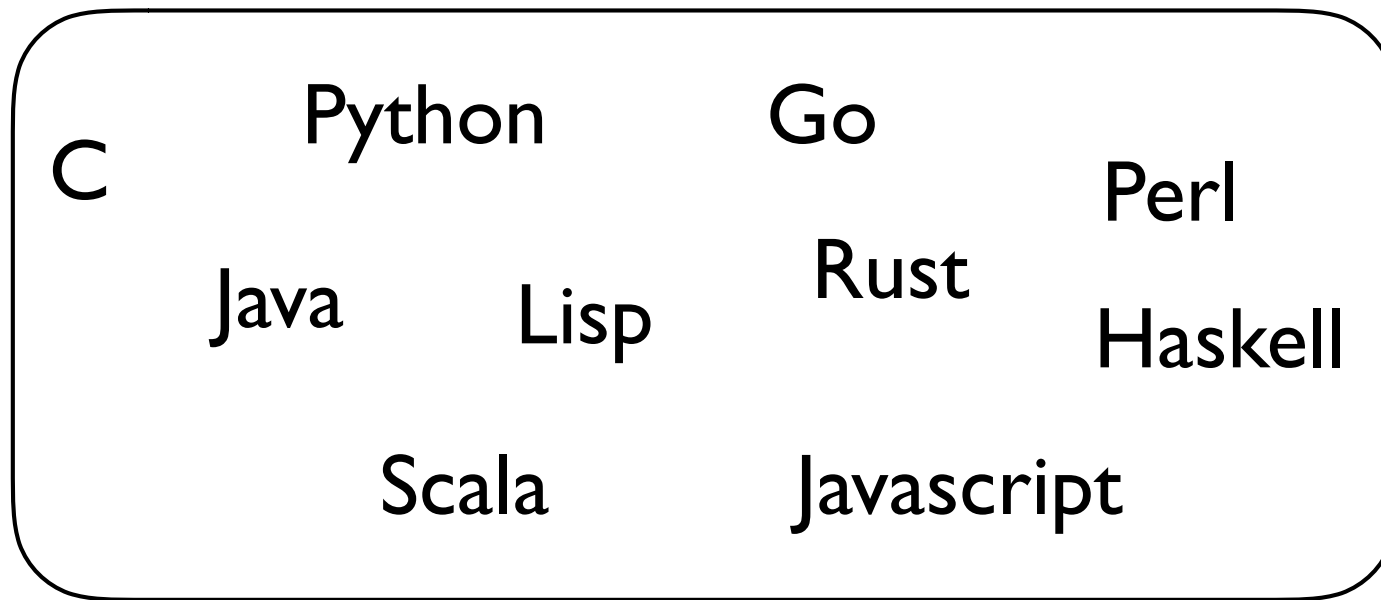- Also a major part of the mathematical foundations of programming languages.

What is Programming?

- Describes a computational process. Yes.

- How? By banging random keys on a keyboard??

- Key feature: Abstraction

Programming is Abstraction

memory

```
          data
5548  89e5  897d
fc00  0f8e  1800
45f8  8b45  fc83
8b45  f85d  c300



        program
ADD R1, R2, R3
SUB R3, R4, R5
...
STO R5, (R6)
...
JNZ 1a
...
JMP 4a40
```

naming

```
x = 3982
```

procedures/functions

```
def spam(x, y, z):
    r = x + y - z
```

control flow

```
while n > 0:
    result = result * n
    n -= 1
```

Programming is Abstraction

C   Python   Go

                         Perl

Java   Lisp   Rust

                         Haskell

Scala   Javascript

Abstraction

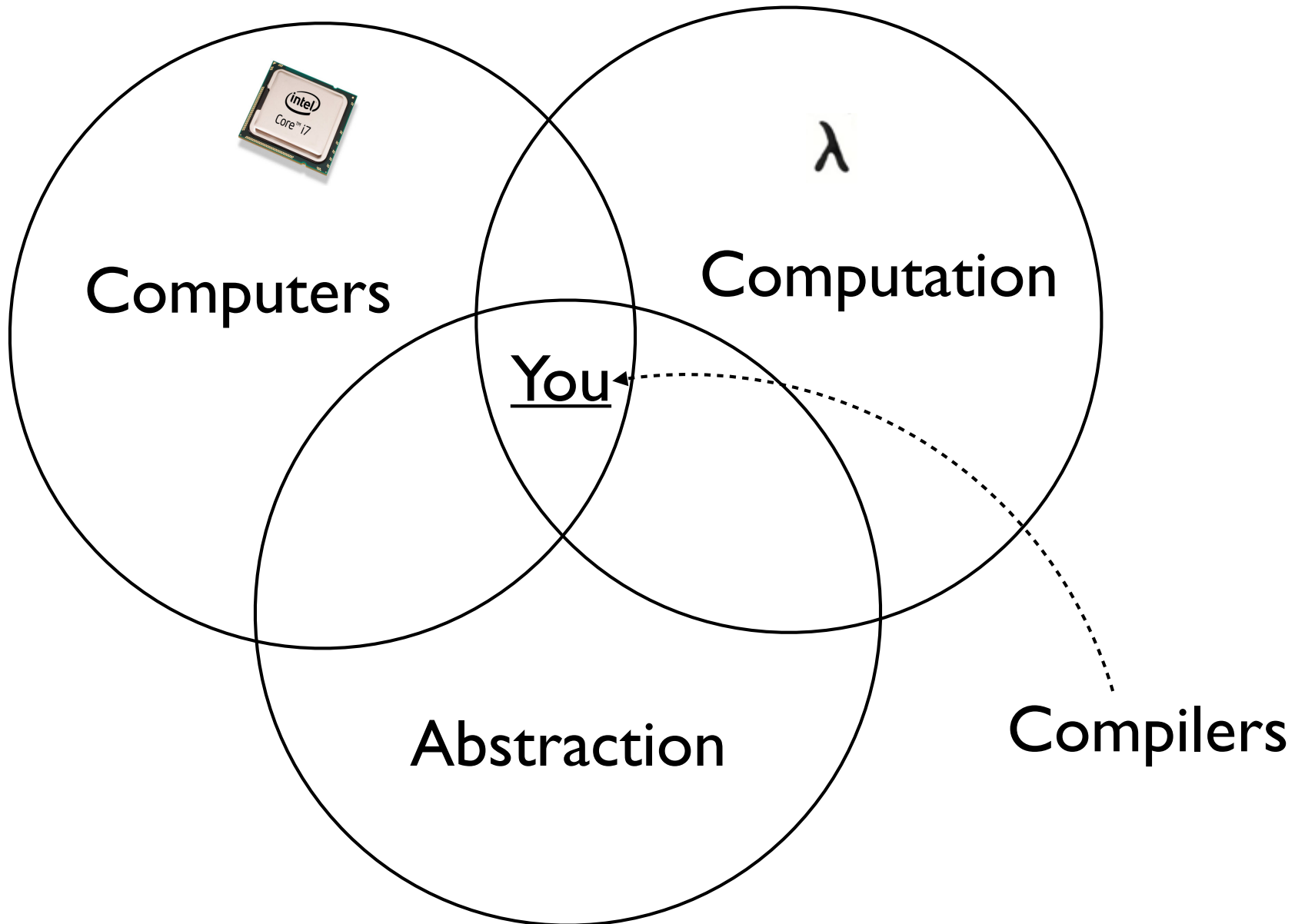"Metal"

010111111   00001111
110001111   11011111
011111011   Bits   11111111
110111111110000000000000000000000000
110000000000000010000000000000000000

Big Picture

Computers

λ

Computation

You

Abstraction

Compilers

Project 0

Find the file `metal.py`

Follow the instructions found inside.

Let's code...

Project 0.5

Play with wabbit

Find the directory `SillyWabbit/`

Follow instructions in the README